Closeout Presentations

From

Director's Review

of

BTeV IR

February 18-19, 2004

Jim Strait, Erich Willen

19 Feb 2004 13:40

1.1 IR Magnets

Findings

- The plan is to use LHC-type quads, developed by Fermilab for the LHC IR, for the main focusing elements, for which there is considerable experience on the basis of which a program plan can be developed. A modest amount of relatively straightforward engineering is required to adapt this design to the Tevatron requirements, and modest modifications to existing tooling will be required. There is one potential R&D topic, which is related to the end restraint method.

- It is planned to design and build a new feedbox for testing these quadrupoles.

- Several options are being considered for correctors, but detailed designs have not yet been developed, and none of the many options for how and who would make the correctors have yet been explored sufficiently to form a solid basis for schedule and cost estimates.

- HTS leads have been specified for the high current supply for the main IR quads, based on considerations of helium cooling capacity. For the moment, the cost estimates and spool designs are based on a plan to use two 6 kA leads of an existing design, operated in parallel, to provide the required 10 kA capacity.

- Five types of new spool pieces, which include the correctors and HTS leads, must be designed and built. The design process is in a very early stage, and is not yet mature enough to be the basis for a cost estimate.

- The team presented a list of long-lead items that would need to be ordered within the next year or so. These include superconductor and collar steel for the main quads, which need to be ordered in early FY2005. Other key magnet parts, (e.g. cryostat vacuum vessels and coil end parts), magnet tooling modifications, the test stand, HTS power leads, and correctors need to be ordered before the end of FY2005.

- A cost estimate was presented. It was based on experience with the LHC quadrupole production, actual costs of LHC correctors being procured by CERN, actual costs of HTS leads procured for the Tevatron, and the DFBX fabrication cost.

- The current level 3 manager is committed to this job through the baseline review anticipated for the late summer. Candidates have been identified who will take over at that point, but the final decisions on the management of the magnet task have not been made.

Comments

- The plan to use the LHC collared coil design for the BTeV quads is appropriate. It would be desirable to set the yoke diameter to be large enough that the same end restraint system currently used in the LHC quads can be used here, eliminating the one potential R&D topic.

- The team needs to evaluate whether it is better to modify the existing Tevatron quench heater firing units to adapt to the heaters used for the LHC, or to change the heater design in the quadrupoles to work with the existing HFU design used everywhere else at Fermilab.

- The team needs to examine the specification for the superconducting wire, in light of recent experience with cable for the FNAL-LHC quadrupoles, to ensure that it will yield good cable. It may be appropriate to follow the strategy used by BNL and CERN, in which the superconductor vendor is responsible to deliver the finished cable .

- Certain long-lead items, especially the superconductor and collar steel for the LHC-type quads, must be ordered as early as possible to ensure that the BTeV IR can be completed as scheduled. Delays in ordering these items can potentially delay the completion of the IR and therefore the readiness of BTeV to begin its research program.

- It would be worth taking a look to see if it would be cost-effective to modify the existing LHC test stand, rather than designing and building a new test stand.

- The advantages of the multiple flat coil design seem minimal relative to the challenges of developing this new design and the added complexity of the power supply and control systems needed to drive it. More conventional shell-type coil structures will certainly do the job in a straightforward way.

- Serious discussions need to be held soon with potential suppliers of the corrector, which could be other labs (who could also provide the detailed designs and could test them) or conventional vendors, both in the US and elsewhere in the world.

- The specifications on the required field strength and margin, and on the required field quality of the correctors need to be spelled out more explicitly, to allow the magnet designers to proceed with developing specific designs.

- While the proposed solution of two 6 kA leads in parallel will work, a single lead carrying the full 10 kA would be much more desirable. Such a design would likely be more reliable, simpler to control, simplify the spool design, and use less cold helium. It is important to decide this question soon and develop the needed designs, since HTS leads are far from being “off the shelf” items. The team should proceed with discussions with potential vendors, in the US, Europe and Japan, to see if an appropriate design can be developed or adapted for this application.

- A considerable amount of engineering work must be done to bring the spool design to the level at which it can form the basis of a cost baseline. Attention needs to be paid to controlling the complexity of the design and ensuring its manufacturability. Contracting with one or more potential vendors to do a design study, as part of the development of the spool design, could be advantageous, as it was for the LHC feedboxes. Adequate manpower must be assigned to the spool design task in order to develop a solid baseline by the summer.

- There is a tendency in a project such as this, which is embedded in an existing complex, to choose solutions based on what already exists or how things have been done in the past. This approach has the evident virtues of ensuring standardization and minimizing the number of new designs that are developed. However, it is also important to evaluate these assumptions to be sure that unwise compromises are not being made in adopting existing solutions.

- The cost estimates presented are reasonable given the level of understanding that the team has today of the job at hand. However, much work needs to be done to develop them to the level required for the project baseline. Once the baseline cost estimate is developed, it needs to be organized and presented in an easily understood and traceable format.

- It is crucial that, by the time of the baseline review, all of the key managers of the magnet task have been identified and their responsibilities define.

Recommendations

1 Provide the required funds in FY2005 to allow the purchase of long-lead items, especially superconductor and collar steel.

2 Decide on the configuration of the HTS leads and start the procurement process.

3 Provide the required technical manpower to develop the corrector and spool designs to the level required for the project baseline.

4 Identify the lead personnel for the magnet task, and define their responsibilities.

Accelerator Physics

Don Edwards, Jei Wei

February 19. 2004

Topics

1. Interaction Region
   - Linear Optics
   - Tracking
   - Beam Losses and Energy Deposition
2. Correction and Adjustment Elements
3. Concluding Remark

Linear Optics

- Findings: The Committee was presented with a mature optics design consistent both with limited changes in Tevatron architecture and the requirements of the BTev experiment.

- Comments: The "either-or" approach to B0-D0 high luminosity or C0 high luminosity wisely avoids the massive changes associated with three high luminosity interaction regions. Beam separation is at or above the traditional 5σ level advocated as a result of s$\bar{p}p$s experience. The two locations at which separation drops to 3.8σ do not strike the Committee as cause for concern.

- Recommendations: It is recommended that the current design be adopted as project baseline.

Tracking

- Findings: The Committee was presented with preliminary tracking results with the inclusion of Tevatron magnet multipoles and interaction region field errors, in order to gain insight into dynamic aperture under collision conditions at C0. Aspects of the resulting tune footprint puzzled the Committee.

- Comments: The tracking was carried out using the program MAD (Methodical Accelerator Design) which as the name implies was not constructed with efficient tracking in mind.

- Recommendations: The Committee recommends that this effort continue, with particular emphasis on identifying the sources of shape modification in the tune footprint. Further, tracking should be carried out with software designed with tracking in mind.

Beam Losses and Energy Deposition

- Findings: Collimation and shielding studies related to radiation sources external to the collision hall have recently been initiated. Results thus far are encouraging, suggestive of levels comparable to those observed at B0 and D0.

- Comments: The destination of the particle fluxes is outside the scope of present study.

- Recommendations: This analysis should continue, including extrapolation to anticipated end-of-run-II luminosity levels and inclusion of detector sensitivities.

Correction and Adjustment Elements

- Findings: Ten spool pieces of new design, with associated magnetic components, will be installed. Two approaches to correction and adjustment elements were presented, one resembling the existing Tevatron variety and the other an innovative assembly of pancake coils capable of generating a variety of multipoles.

- Comments: The existing Tevatron correctors of this were not designed for full-excitation operation other than for diagnostic purposes. They are single layer random-wound coils nested three-deep in each corrector package.

- Recommendations: The Committee does not advocate embarkation on a new design given the limited applicability in this project. The Committee recommends that an analysis be performed of required field quality and distribution consistent with intended use.

Concluding Remark

The Committee found the accelerator physics status very encouraging at this stage, and with preservation of continuity consistent with project schedule and goals..

David Finley and Gerry Annala on BTeV C0 IR Director's Review

Version: February 19, 2004 12:20 PM

1.3 Installation and Operations

Findings

Designs of single IR magnets and single spools were presented to the committee. It was stated that the assumption for connecting the magnets and spools together as a string was to do it like the low beta insertions at B0 and D0. The information presented to the committee did not include how alignment of the IR magnets is to be done.

High temperature superconducting (HTS) leads will be used to connect the electrical power to several of the C0 IR beam line components.

The background rates from several sources were presented along with some preliminary solutions for reducing it. One of these sources is beam gas interactions in the detector beam pipe between the IR triplets.

This committee's charge was confined to considerations outside the C0 detector hall. Some of the committee members were given the results of the "BTeV IR Review" of December 18, 2003. That review addressed several issues inside the C0 detector hall.

The committee was given a presentation on the shutdown scheduled for 2005. This shutdown will be used to remove the remnants of the no longer used abort system, and reconfigure C0 as a normal straight section. The committee was also told that all of the beam line components for the C0 IR low beta insertion and separators will need to be installed in one shutdown in 2009. However, some of the equipment outside the beam enclosure can be installed earlier than the 2009 shutdown.

The Q1 low beta magnets and the P-spools near B0 will be replaced with H-spools and cold spacers.

Collimator(s) will be installed near B48. One plan is to move an unused collimator from another area of the Tevatron.

Several power supplies that will be the operational responsibility of the Accelerator Division will be located in the staging area of the detector hall.

It was stated that all correction circuits and Low Beta Quadrupole circuits will interface to the control system using Camac cards of a design that is already used in the Tevatron.

Comments

Although the design of single IR magnets was presented, there was no detailed information presented on how the magnets are to be connected together as strings of magnets along the Tevatron beam line. The low beta insertions at B0 and D0 do not necessarily employ the best methods for such interconnections.

When the HTS leads presently installed in the Tevatron become wet (from humidity, for example) they can cause problems during operational hipot tests.

It was not completely clear to the committee whether the vacuum requirements on the vacuum in the detector beam pipe between the IR triplets will result in acceptably low enough backgrounds from beam gas interactions.

Although the committee's charge was confined to exclude consideration of the equipment between the C0 IR triplets, the Tevatron beam obviously will not respect such restrictions or boundaries. Understanding the predictions of operational performance of the Tevatron with the C0 IR requires inclusion of all active elements along the full circumference of the beam line.

The work for the 2005 shutdown needs to be planned carefully, as is the intention for any accelerator shutdown, in order to minimize the downtime for the physics program. The same comment applies to the 2009 shutdown. However, a detailed understanding of the interrelationships between various subsystems needs careful attention. As an example, the three dipoles in the detector hall raise several questions that need to be addressed: How and when do these dipoles become installed and operated? How are the two dipoles nearest the triplets to be integrated in the surrounding toroid magnets, and how can they be replaced if necessary?

Naming tunnel components and power supply circuits often change as a project moves from the design stage to operations. Involving an operational person early can eliminate confusion later on. It is not too early for the Level II manager for the C0 IR to delegate the responsibility for determining these names to, for example, the Tevatron Operations Specialist.

Physical real estate in the tunnel can become cluttered in the area of power leads and spool pieces. This can make maintenance and operations problematic. For example, the physical layout of devices containing high current power leads, correction element connections and instrumentation feed-throughs should be reviewed by a person who will be directly involved in Tevatron operation and maintenance.

Collimators that are in the Tevatron beam line that are not regularly used are still used on occasion. They are also attached to local control systems that run operational collimators. The controls for these devices could not be removed if the collimator itself were to be recovered for BTeV.

The installation of the H-spool in A4 will leave two sets of power leads for that house, one of which will be unused and an extra heal load. Replacing the H-spool at A48 would eliminate this problem, but would change the length of the A48 warm bypass. Another solution would be to use an S-spool at A49, but this would leave the Tevatron without a spare S-spool.

Using a warm bypass in the place of the cold spacer at A49 and B11 would provide a small amount of warm space in the beam line. Warm space is always useful, although this may not make sense in these locations.

The committee supports the project's efforts to relocate the synchrotron light monitor in the Tevatron.

Recommendations

1. Assess the possibility of implementing a better way to connect the C0 IR magnets and spools than is presently done at B0 and D0.

2. Involve the Fermilab alignment group at this time in the design of the IR magnets so that alignment of the magnets along the Tevatron beam line can be done efficiently.

3. Investigate possibilities for designing the C0 IR HTS leads to avoid the hipot problems observed with the HTS leads presently installed in the Tevatron.

4. Assess the vacuum requirements in the beam pipe passing through the detector between the IR triplets, either to assure that the background rates are acceptable, or to redefine the specifications on the vacuum so that they are acceptable.

5. Include in future presentations of beam simulations and energy loss simulations issues arising from the detector hall that affect operation of the Tevatron beam, such as the three dipole magnets in the detector hall.

6. Develop sufficiently detailed engineering designs of the subsystems and components so that detailed plans can be made to assure that sufficient time can be provided in the shutdowns in 2005 and 2009 to complete the work required.

7. Establish interlock enclosure boundaries and determine configuration control responsibilities of the Accelerator Operations Department, since this may have impact on installation of electrical infrastructure in the near future.

8. Establish final names of magnets, power supplies, and other devices that will be in the controls system.

9. Involve an operational person from either the Tevatron Department or the Operations Department who will be concerned with placement of power bus, water lines, utilities, etc. in the tunnel and service building.

10. Consider the possibility of creating another S-spool to be used at A49, and using a warm bypass in place of a cold spacer at both A49 and B11.

11. Consider planning for a completely new collimator installation at B48 rather than using already installed components.

1.4 Schedule

Jerry Annala
Don Edwards
Dean Hoffer

Findings

- WBS has been established at Level 2 of the IR subproject and Managers have been assigned at that WBS level.
- The Converting C0 to normal straight section (WBS 2.2) is planned for the 2005 shutdown with the duration of 8weeks.

Findings (cont.)

- A MS Project schedule exists for WBS 2.1 “Magnet Fabrication and Testing” which includes R&D activities, MIE activities and fabrication of spares. This plan will be migrated into an Open Plan schedule.
- An Open Plan schedule exists for the other IR Subprojects WBS 2.2 – 2.8.

Findings (cont.)

- The two schedule files are in the early development stage and management milestones have not been established and incorporated into the schedules.
- WBS 2.8 “Commissioning” contain both the technical commission activities to meet CD-4 and the additional commissioning activities to make the IR operational.

Findings (cont.)

- 54" Low Beta Quads that are not powered for Run II will be removed from A4 and B1. P-spools that interface with these Quadrupoles will also be removed and used as part of the BTeV project.

Comments

- Key management milestones should be established and incorporated into the schedule for preparations of the CD-1 review.
- The WBS in the MSP schedule file for the Magnet Fabrication and Testing has been decomposed to a lower level than the WBS for the other 7 subprojects. The reviewers agree that additional breakdown of activities needs to be accomplished. This helps in validating resource estimates and the statusing/managing progress in the future.

Comments (cont.)

- The current schedule need to be analyzed and modified based on resource and budget availability, which has not been done because of the early stage of schedule development.
- All the IR Subproject need to be integrated into one Open Plan file with the appropriate links established between the IR subprojects. Then the IR schedule is to be integrated with the master BTeV schedule with the Detector and Outfitting level 2 projects.

Recommendations

- The items noted in the Comment section above require time and effort to successfully accomplish. It is recommended that additional support be allocated to help Mike Church in the development of the IR Schedule.
- WBS 2.8 “Commissioning” scope needs to be revised to contain the Technical Commission scope to meet CD-4 and move the other commissioning activities and cost to off project.

Recommendations (cont.)

- The replacement of the 54" Low Beta Quads require a warm up of each house. This type of thermal cycle takes approximately 2 weeks and substantial manpower. Preparing for this replacement to take place as soon as possible would be useful as a necessary repair could force a thermal cycle of one of these houses at any time. Replacing the needed devices during an unscheduled thermal cycle would result in BTeV gaining access to devices early as well as saving time in later critical shutdowns. This should be incorporated into the plan.

Jim Strait, Dave Finley, Erich Willen

19 Feb 2004 13:40

1.5 Cost Estimate

Findings

- Base cost estimates (in ~FY05$) which include G&A have been prepared. The team is not ready at this point to present a contingency analysis or include a contingency amount in the estimate. Escalation has not been included in the estimate.

- It is intended that all cost estimates will be entered into Open Plan, but much of the data have not been entered yet.

- The magnet cost estimates are based on experience with the LHC quadrupole production, actual costs of LHC correctors being procured by CERN, actual costs of HTS leads procured for the Tevatron, and the DFBX fabrication cost.

- For most of the rest of the project, the basis of estimate is past experience doing similar jobs.

Comments

- The basis of estimate (BOE) for some elements (for example, cryogenics) is quite good, but in other areas (for example, instrumentation or magnets) much remains to be done. The Level 2 IR Manager feels the BOE can be completed prior to the upcoming CD-1 Director's Review and DOE Review. Given this, it can certainly be ready for the CD-2 Baseline Reviews.

- The magnet cost estimates presented are reasonable given the level of understanding that the team has today of the job at hand. However, much work needs to be done to develop them to the level required for the project baseline.

- As the baseline cost estimate is developed, it is important that it be organized and presented in an easily understood and traceable format.

- The estimates currently include some costs which are usually excluded from the capital cost of a project such as this, for example some R&D, spares, and some physicist labor. Management needs to decide which costs will ultimately be included in the baseline budget for this project.

- A contingency analysis would be desirable for the CD-1 Reviews. Also, as spent costs, which include escalation should be presented. To include escalation an assumed funding profile constrains the schedule. The assumed profile should be consistent with the FY05 President's Budget.

Recommendations

1. Continue efforts to complete the BOE, contingency analysis, and inclusion of escalation prior to the upcoming CD-1 Reviews.

2. Provide clear definition of which costs are included as part of the project baseline and which are to be funded from the operating budget.

Jie Wei, Ed Temple

February 19, 2004/12:15pm

(Management)

Findings

- The committee was presented verbally with a project luminosity goal of 1e32 to 2e32 / cm^2s for the BTeV project. There was no clear definition of CD4 goals.
- The committee was presented with an organization chart and a WBS structure including names of all level 2 and level 3 managers for BTeV IR. The IR level 2 manager assumed his role since October 2003, and assumes no line management responsibility on anyone on the project.
- Presently the level 2 manager is the only person full time on the BTeV IR project. The level of effort of the rest of his level 3 managers is approximately between 20 to 50%.
- The IR level 2 manager has been receiving strong support from both accelerator and technical divisions on almost all areas. Some additional efforts may be needed in accelerator "theory".
- The accelerator physics effort is presently not in the WBS structure. It seems that the present accelerator physics efforts may not be sufficient to support the integration with other technical systems.
- Weekly meeting has been started among all level 1 and level 2 managers on the project.
- The committee was presented with a level 3 WBS on non-magnetic part of efforts and components. Based on uncertainties and risks, the amount of contingency varies from approximately 20% to 60%. No detailed WBS was presented on the magnetic part of efforts and components.

Comments

- The IR part of the project may need a set of goals for CD4 and for the final delivery. The final goal may be on the luminosity to be delivered. The CD4 goal may be on the installation completion and readiness of all machine hardwares to achieve the final goal.
- The IR level 2 manager needs to continue identifying key personnel to form a core group for the project. An agreement needs to be made with division heads for the long term commitment of key personnel's efforts on the project.
- A strong, coordinated accelerator physics team is essential for the technical integration of various systems within BTeV IR, between IR part and the rest (detector, civil engineering) of the BTeV project, and between BTeV and the rest of Tevatron.
- Since key personnel are distributed in different groups and divisions, regularly scheduled meetings involving all level 3 managers and core personnel may be important.
- The project may consider to establish a database with agreed-upon naming conventions to track various systems within the scope of the project (magnets, power supplies, etc.)

Recommendations

1. Clearly define a CD4 goal and final goal for the BTeV IR project
2. Identify accelerator physics support as a level 3 WBS item, and appoint corresponding level 3 manager / team leader

Executive Summary

A Conceptual Design Report (CDR) for the BTeV Interaction Region (IR) has been written. This CDR sets forth the requirements of the IR for BTeV operations and describes concepts for meeting these requirements. It presents the accelerator physics and beam optics design for the IR and addresses the conceptual design for the superconducting quadrupole magnets and correctors, and cryogenics systems, vacuum systems, controls, and beam instrumentation required to support the new BTeV low beta interaction region. This conceptual design is judged to be a reasonable basis for proceeding to more detailed design for the IR.

Accompanying cost and schedule information was presented. This information is in the early developmental stage. Additional effort to develop and document the work breakdown structure (WBS), a resource loaded schedule and the cost estimate will (need to) be exerted between now and the time of a DOE CD-1 Lehman Review scheduled in April 2004.

The accelerator physics design has progressed to a stage that it can be "frozen" and considered the basis for component selection and component design decisions. Additional work on tracking is desirable.

The LHC High Field Gradient Quadrupoles form a good basis for the BTeV Low Beta IR Quadrupoles. A baseline concept and one alternate concept were presented for the high temperature superconduction (HTS) leads and the correction coil windings and configuration.

The BTeV project and the BTeV IR subproject are being undertaken within the Fermilab matrix management paradigm. Critical resources have been made available for the CDR preparation. Such resource needs will continue through the complete development of the WBS, schedule, resource loading of the schedule, and detailed basis of estimate through the Spring and Summer. In some areas manpower needs will then be relaxed until funding is available for work to start.

Contingency and escalation will need to be applied to the more refined cost estimates at the upcoming CD-1 and CD-2 reviews.